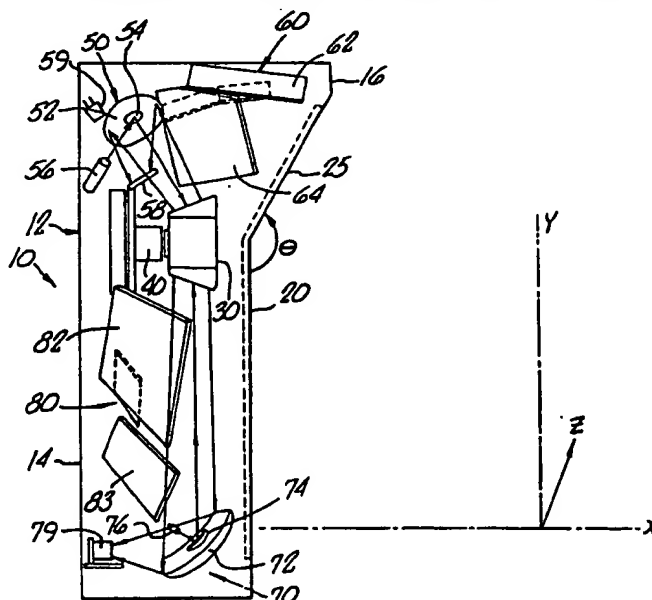




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁵ : G06K 15/00	A1	(11) International Publication Number: WO 94/01835 (43) International Publication Date: 20 January 1994 (20.01.94)
(21) International Application Number: PCT/US93/06642 (22) International Filing Date: 14 July 1993 (14.07.93) (30) Priority data: 07/913,580 14 July 1992 (14.07.92) US (71) Applicant: SPECTRA-PHYSICS SCANNING SYSTEMS, INC. [US/US]; 959 Terry Street, Eugene, OR 97402-9102 (US). (72) Inventors: BOBBA, Mohan, LeeLaRama ; 2857 Metolius, Eugene, OR 97401 (US). ACOSTA, Jorge, L. ; 4907 Cone Avenue, Eugene, OR 97402 (US). EUSTERMAN, Timothy, J. ; 8826 Saddlehorn, Apt. 169, Irving, TX 75063 (US).		(74) Agents: RAFTER, John, A., Jr. et al.; Lyon & Lyon, 611 West Sixth Street, 34th Floor, Los Angeles, CA 90017 (US). (81) Designated States: European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i>

(54) Title: MULTIPLE PLANE SCANNING SYSTEM FOR DATA READING APPLICATIONS**(57) Abstract**

An optical system and method for data reading. The preferred system is directed to a scanner (10) which includes a mechanism for generating first optical beam and a second optical beam, the first optical beam being directed toward one side of a scanning optical element such as a rotating polygon mirror (30) and to a first mirror array (62, 68), the second optical beam being directed toward a second optical element such as another side of the rotating polygon mirror and then to a second mirror array (82, 87). The first mirror array (62, 68) is configured to generate a scan pattern having an apparent source from one orthogonal direction and the second mirror array (82, 88) is configured to generate a scan pattern having an apparent source from another orthogonal direction. The first and second optical beams may operate simultaneously or alternately. In a preferred embodiment, return signals detected from both the first and second optical beams are processed by a single microprocessor (135) to allow for unified signal processing.

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DESCRIPTIONMultiple Plane Scanning System for
Data Reading ApplicationsBackground of the Invention

The field of the present invention relates to optical scanning systems and particularly to a scanning system capable of successfully reading objects aligned in a variety of orientations. The invention is especially
5 suitable for use as a fixed scanner such as that employed at a supermarket checkout counter reading bar codes such as those found on consumer products.

For effective and accurate performance, a bar code
10 scanner depends upon focused optics and scanning geometry. Fixed scanners frequently employ a rotating polygon mirror which directs a scanning beam toward a mirror array for generating a desired scan pattern. One type of fixed bar code scanner positions a scan engine in a base with a scan
15 window oriented in a horizontal plane. One such scanning system is disclosed in United States Patent No. 5,073,702 in which a scanning beam is reflected off a mirror array which has a plurality of mirrors arranged in a generally semicircular pattern. The scanning beam reflecting off
20 each of the mirrors has vertically upward component thereby passing through the window/aperture. Objects to be scanned are passed over the window with the bar codes oriented in a generally downward direction.

In another scanner orientation, the scan engine is
25 housed in a vertical tower with the scan window oriented in a vertical plane. In such a vertical scanner, generally all the outgoing scan beams come out sideways also have an upward vertical component. Objects to be scanned are passed in front of the window with the bar
30 codes oriented in a generally sideward direction.

In order to produce a successful scan, an object must be oriented with its bar code passed in front of the scan

window at an angle which is not so oblique as to prevent a scan line from striking or "seeing" the bar code. Therefore to achieve a successful scan, the user must position the object with the bar code placed sufficiently close to the desired orientation. The range of suitable plane orientation of the object bearing the bar code is limited by the size of the window and the angle over which the mirror array can direct a scan pattern. Present vertical scanners can scan bar codes oriented in a generally vertical plane (i.e., side facing) but cannot scan bar codes oriented in a horizontal plane (i.e., facing up or down). The present inventors have recognized that it would be desirable to increase the range of plane orientation readable by a scanning which would minimize required bar code label orientation, support belt to belt (automatic) scanning, and otherwise provide for improved scanning ergonomics.

Summary of the Invention

The present invention relates to an optical system and method for data reading. The preferred system is directed to a scanner which includes means for generating a first optical beam and a second optical beam, the first optical beam being directed toward one side of a first scanning optical element such as a rotating polygon mirror and to a first mirror array, the second optical beam being directed toward a second scanning optical element such as another side of the rotating polygon mirror and then to a second mirror array. The first mirror array is configured to generate a scan pattern having an apparent source from one orthogonal direction and the second mirror array is configured to generate a scan pattern having an apparent source from another orthogonal direction. The first and second optical beams may operate simultaneously or alternately. In a preferred embodiment, return signals detected from both the first and second optical beams are

processed by a single microprocessor to allow for unified signal processing.

Brief Description of the Drawings

Fig. 1 is a front perspective view of a vertical scanner according to the present invention;

Fig. 2 is a partially diagrammatic right side elevation view of the scanner of Fig. 1;

Fig. 3 partially diagrammatic top plan view of the scanner of Fig. 1;

Fig. 4 partially diagrammatic front side elevation view of the scanner of Fig. 1;

Fig. 5 is a diagrammatic top plan view of the scan pattern along a horizontal plane generated from the upper mirror array of the scanner of Fig. 1;

Fig. 6 is a diagrammatic front side elevation view of the scan pattern along a vertical plane generated from the lower mirror array of the scanner of Fig. 1;

Fig. 7 is a schematic diagram illustrating a preferred polygon mirror light scanning and collecting configuration;

Fig. 8 is a schematic diagram illustrating an alternate polygon mirror light scanning and collecting configuration;

Fig. 9 is a schematic diagram illustrating another alternate polygon mirror light scanning and collecting configuration;

Fig. 10 is a detailed view of the shutter of Fig. 9 taken along line 10-10;

Fig. 11 is a schematic diagram illustrating another alternate polygon mirror light scanning and collecting configuration;

Fig. 12 is a schematic diagram illustrating another alternate polygon mirror light scanning and collecting configuration;

Fig. 13 is a schematic diagram illustrating another alternate polygon mirror light scanning and collecting configuration;

5 Fig. 14 is a schematic diagram illustrating an alternate light scanning and collecting configuration using an pair of movable mirrors;

Fig. 15 is a schematic diagram illustrating a holographic disk light scanning and collecting configuration;

10 Fig. 16 is a schematic diagram illustrating an alternate holographic disk light scanning and collecting configuration;

15 Fig. 17 is a schematic diagram illustrating a dual holographic disk light scanning and collecting configuration;

Fig. 18 is a flow chart of a preferred light scanning and collecting processing scheme;

Fig. 19 is a flow chart of an alternate light scanning and collecting processing scheme; and

20 Fig. 20 is a front perspective view of a combination vertical and horizontal scanner.

Description of the Preferred Embodiment

The preferred embodiments will now be described with reference to the drawings. Fig. 1 is a schematic diagram
25 of a preferred vertical scanner 10 having a housing 12 with a lower housing portion 14 and an upper housing portion 16.

The scanner 10 generates a scan volume generally designated 5 by scanning beams projected outwardly through
30 lower and upper windows 20 and 25. In order to facilitate referral to relative directions, orthogonal coordinates (X, Y, Z) are designated in Fig. 1. The X coordinate is defined as a sideways direction, perpendicular to or horizontally outward from the lower window 20 of the scanner
35 housing 12; the Y coordinate is defined as a vertically upward direction; and the Z coordinate is defined as

another horizontal direction parallel to the lower window 20.

Figs. 2-4 illustrate the internal scanning beam generation and collection configuration of the scanner 10.

5 The scanner 10 has two windows namely a lower window 20 and an upper window 25 arranged at an oblique or inclined angle to one another. The scanner 10 may alternately have a single vertical or inclined window, but the dual window configuration provides physical information to the user
10 regarding the direction of the scanning beams, namely that one scanning beam pattern is generally emanating from the upper window 25 and one scanning beam pattern is generally emanating from the lower window 20.

The scan engine of scanner 10 has a central rotating
15 polygon mirror 30 driven by a motor 40. In the lower housing portion 14, a light source 76 generates a beam of light and directs it toward mirror 74. The light source 76 may be a laser, laser diode, or any other suitable source. The mirror 74 focuses and reflects light toward
20 the polygon mirror 30 which has four mirror facets 31, 32, 33, 34. As the polygon mirror 30 rotates, the outgoing beam is directed across the lower mirror array 80 and then reflected out through the lower window 20 to achieve a desired scan pattern. Light reflecting off the target
25 returns via the same path and is collected by a collection mirror 72 and focused onto a detector 79. The polygon mirror 30 is preferably molded in a single piece out of emanating, but could be constructed out of acrylic or other optical materials including other plastics, metals
30 or glass by one skilled in the art. The outer surface of each mirror facet may be advantageously coated with a suitable high reflective coating, the coating chosen would depend upon the optical material of the polygon mirror 30. For example, a emanating or acrylic facet may have a
35 metallic coating such as aluminum or gold, while a metal or glass facet may be preferably coated with a single or

multi-layered dielectric such as silicon dioxide (SiO_2) or titanium dioxide.

The outgoing beam mirror 74 and the incoming collection mirror 72 are also preferably an integral unit of one-piece construction forming a mirror unit 70. Both mirror elements are optically powered, the smaller outgoing mirror 74 being parabolic and the larger collection mirror 72 being ellipsoidal.

Simultaneously (or intermittently if desired) to the operation of the lower scan generation, an upper light source 56 generates a beam of light and directs it toward mirror 54. The light source 56 may be a laser, laser diode, or any other suitable source. The mirror 54 focuses and reflects light toward the polygon mirror 30. As the polygon mirror 30 rotates, the outgoing beam is directed across the upper mirror array 60 and then reflected out through the upper window 25 to achieve a desired scan pattern. Light scattered off the target returns the same path and is collected by a collection mirror 52, reflecting off fold mirror 58 and focused onto a detector 59. The outgoing beam mirror 54 and the incoming collection mirror 52 are preferably an integral unit of one-piece construction forming a mirror unit 50. Both mirror elements are optically powered, the smaller outgoing mirror 54 being parabolic and the larger collection mirror 52 being ellipsoidal.

Outgoing light beam from the upper source 56 reflects off one side of the polygon mirror 30 while simultaneously the light beam from the lower source 76 reflects off an opposite side of the polygon mirror 30. The upper mirror array 60 cooperates with the rotating polygon mirror 30 to generate the scan pattern 90 shown in Fig. 5. Fig. 5 is a diagrammatic top plan view of a scan pattern 90 of scan lines 92 as shown in a horizontal X-Z plane at the base of the scanner 10.

The lower mirror array 80 cooperates with the rotating polygon mirror 30 to generate the scan pattern 95

shown in Fig. 6. Fig. 6 is a diagrammatic front elevation view of a scan pattern 95 of scan lines 97 as shown in a vertical Y-Z plane located at a distance of 6.0 in. (15.24 cm) from the scanner 10. From the above description and
5 the scan patterns disclosed, one skilled in the art may construct a suitable polygon mirror 30 and mirror arrays 60, 80 to achieve the desired scan patterns.

As shown in Figs. 2-4, the mirror arrays 60, 80 comprise a plurality of pattern mirrors arranged generally
10 in what may be described as a semicircular pattern. The pattern mirrors may be configured to produce a multitude of desired scan patterns. The scanner 10 projects scanning sweeps along two generally orthogonal directions, one scanning sweep emanating generally downwardly and side-
15 wardly from the upper inclined window 25 and one scanning sweep emanating generally sidewardly and upwardly from the vertical lower window 20. It is the cooperation of these two scanning sweeps emanating from different scanning directions which result in enhanced scanning range. The
20 mirror arrays 60, 80 may be designed to produce a desired scan pattern for a particular application.

The upper window 25 is arranged at an oblique angle θ to the vertical lower window 20 of about 150° . The lower window 20 and upper window 25 are preferably constructed from glass, plastic or other suitable material.
25 In an application where it is anticipated objects may strike the window, it may be coated with a suitable scratch resistant coating or even constructed of sapphire. The lower and upper windows may constitute first and
30 second window elements or may simply be apertures through which the scanning beams pass. The first window element is defined to be oriented in a first aperture plane and the second window element is defined to be oriented in a second aperture plane, the first aperture plane being
35 oriented at an angle θ to the second aperture plane. Preferably the angle θ is greater than 90° and somewhat less than 180° , with a preferred angle of 150° .

Though in actuality the scan patterns generated by each mirror array 60, 80 are truly three dimensional, the scanning sweep generated by each of the mirror arrays may be generally described as a scan plane, the plane being
5 defined by a median of scan lines emanating from the respective mirror array, positioning the plane in a coplanar orientation with the semicircle of the mirror array. By positioning the mirror arrays 60, 80 on opposite sides of the polygon mirror 30, the scan planes
10 emanating from the mirror arrays intersect in the scan volume, the volume through which the objects to be scanned are passed. In an application of a vertically oriented scanner in a market checkout stand, the angle of the intersecting scan planes is preferably between about 30°
15 and 90° with a preferred angle of about 60°.

Though the preferred scanning system is described as a fixed scanner with objects bearing a symbol such as a bar code being passed through the scan volume, alternately the scanner and the scan volume may be moved past a sta-
20 tionary object. Such a configuration may be desirable for inventory management or large object scanning applications for example. In either the fixed or moving scanner case, the object is being passed through the scan volume.

Alternately, the scanner window (if a single window
25 is employed) or the scanner windows 20, 25 may comprise holographic elements to provide additional scan pattern directional control. As described above, Figs. 2-4 illustrate a preferred beam generation and collection configuration. That configuration is also diagrammatic-
30 ally illustrated in Fig. 7. Light source 56 generates a beam of light onto a small aiming mirror 54 which focuses and reflects the light toward one side of the rotating polygon mirror 30 which scans the beam across the upper mirror array. Light returning from the target is
35 collected by the collection mirror 52 and directed toward the detector 59. At the same time, the lower light generation and collecting system generates a light beam from

light source 76 onto an aiming mirror 74 which focuses and reflects the light toward the opposite side of the rotating polygon mirror 30 which scans the beam across the lower mirror array. Light returning from the target is
5 collected by the collection mirror 72 and directed toward the detector 79.

The configuration may also include additional components depending upon the application. For example, an optical element 58, 78 such as an aperture, filter or
10 grating may be positioned in the outgoing light path to block out undesirable incoming light rays or provide some other desired function.

Fig. 7 illustrates only one preferred beam generation and collection configuration, but other configurations may
15 be implemented. By way of example, certain alternate configurations are set forth in Figs. 8-17 and will now be described.

Fig. 8 diagrammatically illustrates an alternate light generation and scanning configuration which employs
20 a single light source 216. The light source 216 generates a beam of light through a focusing lens 217 which focuses the beam to reflect off a small fold mirror 220 which in turn directs the beam to a beam splitter 224. The beam splitter 224 has two functions (a) reflecting a portion of
25 the light toward the polygon mirror 230 and (b) allowing a portion of the light to pass through to be directed by fold mirror 227 toward another side of the polygon mirror 230. On either side of the polygon mirror, the light beam is scanned across the respective mirror array generating
30 the desired scan patterns. Light returning from the target reflects off the respective mirror array, the respective side of the polygon mirror 30, and then reflects off beam splitter 224 and mirror 227 and is collected by the collimating lens 222 onto detector 219.
35 In this embodiment having only a single detector 219, the system may require processing electronics for handling simultaneous signals. Alternately, the beam splitter 224

and the mirror 227 may be provided with a pivoting means or a shutter may be positioned in one or more of the light paths so that only one incoming beam is permitted at a given instant. Yet another design may comprise specific
5 alignment of the beam splitter 224 and mirrors 227 and 230 so that only a single incoming signal is received by the detector 219 at a given instant. Yet another alternative design may include a separate detection system for the return beam associated with mirror 227.

10 Alternately, such a design may be configured with a rotating or pivoting fold mirror (for example in place of the beam splitter 224) which would alternately direct the light beam toward the fold mirror 227 or directly to the polygon mirror 230.

15 Figs. 9-10 illustrate an alternate single light source configuration in which a light source 236 generates a beam of light which is focused by a focusing lens 234 (optional) and directed by a fold mirror 238 through a combination lens element 244 having a outgoing beam
20 lenslet portion 248 and an incoming beam collection lens portion 246. The outgoing beam from the fold mirror 238 is focused by the lenslet 248 toward the shutter mirror 250. The shutter mirror 250 is a round shutter element rotated by a motor 258. The shutter mirror 250 has an
25 outer support ring 254 with a portion of its circular surface comprising a reflecting mirror portion 252 and the remaining portion being a void 256.

When the mirror portion 252 is aligned in the beam path, the light beam is reflected toward the polygon
30 mirror 240 and returning signal is reflected back to the collection lens which focuses the collected beam onto detector 239. When the void portion 256 is aligned in the beam path, the light beam passes therethrough and is then reflected off fold mirror 242 toward the polygon mirror
35 240 and returning signal is reflected back off the fold mirror 242, passing through the void portion 256 and on to the collection lens which focuses the collected beam onto

detector 239. The relative size of the mirror portion 252 and the void portion 256 may be selected to adjust the relative amount that the upper and lower scanning is operated. In the preferred embodiment, a majority of the scanning beam would be directed to the upper scanning portion (e.g. 60%-70%) so the mirror portion 252 would be a larger arc (216° - 252°) than the void portion (144° - 108°).

Fig. 11 illustrates another alternative light scanning and collecting scheme. Separate light sources 262, 270 each generate a beam of light which is focused by a focusing lens 264, 272 and then passes through an aperture 268, 275 in a concave collecting mirror 267, 274. The light beam then is reflected off a respective fold mirror 265, 277 and then to either side of the polygon mirror 260. Beams are then scanned across respective mirror arrays and reflected signals return reflecting off the polygon mirror 260 facet, off fold mirror 265, 277 and then are collected by respective collection mirror 267, 274 to detector 269, 279. One side of the collection system also illustrates an additional focusing lens 278 in the light path between the collection mirror 274 and the detector 279 to assist in focusing the collected signal beam.

Though the previous embodiments illustrate a single polygon mirror for the optical scanning element or mechanism, other configurations may be employed such as for example a rotating optical polygon of any suitable number of facet mirrors, a rotating holographic disk, a pair of rotating single facet mirrors, and a pair of pivoting single facet mirrors, or any other suitable scanning mechanism. Some of these alternate designs will now be discussed.

Fig. 12 illustrates a scanning system having a first polygon mirror 284 and a second polygon mirror 282 driven by a common motor 280. The first and second polygon mirrors 284 and 282 may be mounted coaxially on a common

shaft 281. The two light generation and detection schemes are schematically designated as elements 286, 288 and may comprise any suitable single or dual light source and any suitable light detector configuration such as those
5 already described in the above embodiments.

Similarly, Fig. 13 illustrates a light scanning and collecting scheme having a first polygon mirror 292 and a second polygon mirror 294 arranged side-by-side. The polygon mirrors 292, 294 may be driven by a common motor
10 through transmission means in the base 290. The two light generation and detection schemes are schematically designated as elements 296, 298 and may comprise any suitable single or dual light source and any suitable light detector configuration such as those already described in
15 the above embodiments.

Figs. 12 and 13 illustrate two polygon mirror arrangements, but other arrangements may be employed. For example, the polygon mirrors may be stacked one on top of the other driven on a common shaft. The mirrors in any
20 multiple mirror configurations may be of different size and different number of facets depending upon the particular application.

Fig. 14 illustrates yet another alternative light scanning and collecting configuration. In this configuration, the optical scanning element comprises a pair of
25 pivoting single facet mirrors 308, 318. Light source 300 generates a beam of light onto a small aiming mirror 302 which focuses and reflects the light toward pivoting mirror 308 which pivots to scan the beam across the first mirror array. Light returning from the target reflects
30 off the first mirror array and then the pivoting mirror 308 and is collected by the collection mirror 304 and directed toward the detector 306. At the same time, the lower light generation and collecting system generates a
35 light beam from light source 310 onto an aiming mirror 312 which focuses and reflects the light toward the pivoting mirror 318 which pivots to scan the beam across the second

mirror array. Light returning from the target reflects off the second mirror array and then the pivoting mirror 318 is collected by the collection mirror 314 and is directed toward the detector 316.

5 Fig. 15 illustrates yet another alternative light scanning and collecting configuration. In this configuration, the optical scanning element comprises a rotating holographic disk 320 mounted on a motor and support frame 321. Separate light sources 322, 332 each generate a beam
10 of light which is focused by a respective focusing lens 324, 334 and then passes through an aperture 327, 337 in a respective concave collecting mirror 328, 338. The light beam then is reflected off a respective pivoting fold mirror 326, 336 and then to either side of the rotating holographic disk 320. Beams are then scanned,
15 reflecting off respective fold mirrors 327, 337, across respective mirror arrays toward the target. Return signals are directed through the holographic disk, off pivoting fold mirror 326, 336 and then are collected by
20 respective collection mirror 328, 338 to detector 329, 339.

Fig. 16 illustrates an alternate light scanning and collecting configuration employing a single light source 342 which sends a beam of light toward a small fold
25 mirror 344. Light reflecting off the fold mirror 344 passes through the inner lens portion 347 of lens 346 which focuses the outgoing beam toward pivoting or rotating fold mirror 350. Pivoting mirror 350 alternately directs light either toward pivoting fold mirror 352 or
30 pivoting fold mirror 356 depending upon the orientation of the pivoting mirror 350. Light beam from the respective pivoting fold mirror 352, 356 passes through a respective side of a rotating holographic disk 340. Beams passing through the holographic disk are then scanned, reflecting
35 off respective fold mirrors 354, 358, across respective mirror arrays and reflected signals return being directed through the holographic disk, off pivoting fold mirror

352, 356 are collected by focusing lens 348 onto detector 359.

Fig. 17 illustrates yet another alternate light scanning and collecting configuration, this one employing first and second holographic disks 360, 370. The two light generation and detection schemes are schematically designated as elements 362, 372 and may comprise any suitable single or dual light source and any suitable light detector configuration such as those already described in the above embodiments. The first and second holographic elements 360, 370 may be mounted separately and driven by separate motors, but preferably as illustrated may be mounted on a common axis or shaft 368 and rotatably driven by a single motor 366. The light beam from the first element 362 is directed through the first holographic disk 360 and reflected off the fold mirror 364 and scanned across the first mirror array. Similarly, the light beam from the second element 372 is directed through the second holographic disk 37 and reflected off the fold mirror 374 and scanned across the second mirror array. Return beams follow the same path and are detected in respective collection elements.

The above described scanning and collecting configurations are but a few examples of suitable configurations. Portions of some of the configurations may readily be combined with and modify other configurations.

Fig. 18 is a flow chart of a preferred light scanning and collecting processing scheme. A first (bottom) laser diode light source 107 and second (top) laser diode light source 105 generate light beams toward a respective bottom scan head 112 and top scan head 110. Scan beams from both the top scan head 110 and the bottom scan head 112 are reflected off a common facet wheel 115 or polygon mirror. Since the design may employ a common polygon mirror, the system requires only a single motor assembly resulting in reduced unit size, weight and cost as well as power consumption. Return signal is collected at top and bottom

collection optics 120 and 122, with the signals processed in respective analog signal processing units 125, 127 and then converted and processed in respective digital processors 130, 132. The processed raw data from both digital processors 130, 132 is then inputted into a first microprocessor 135 where the signals are analyzed and processed together. This common processing allows for enhanced efficiency and scanning advantages. For example, a partial bar code scanned by a scan line generated from the top scan head 110 and collection optics 120 may be stitched together with a partial bar code scanned by a scan line generated from the bottom scan head 112 and collection optics 122 to achieve a complete scan. A second microprocessor 140, which may be separate from or included within the first microprocessor 135, may optionally integrate data input from a weigh scale 197. Once processed, data from the processor 140 is outputted to an application system illustrated as the point of sale system 195.

Fig. 19 is a flow chart of an alternate light scanning and collecting processing scheme. A first (bottom) laser diode light source 157 and second (top) laser diode light source 155 generate light beams toward a respective bottom scan head 162 and top scan head 160. Scan beams from both the top scan head 160 and the bottom scan head 162 are reflected off a common facet wheel 165. The return signal is collected at top and bottom collection optics 170 and 172, with the signals processed in respective analog signal processing units 175, 177 and then inputted into a multiplex timer circuit 180 so that the bar code signals from the top and bottom may be successively combined and transmitted to the decoding I/F electronics unit 185. This common processing allows for enhanced efficiency and scanning advantages similar to the previous embodiment. The decoding microprocessor 185 may optionally integrate data input from a weigh scale 147.

Once processed, data from the processor 185 is outputted to the point of sale system 145.

The scanning system may also be combined with a horizontal scanner. Fig. 20 illustrates a combination
5 vertical and horizontal scanner 410. The scanner 410 includes a housing 412 with a lower housing portion 414, an upper housing portion 416, and a lower horizontal portion 418. The scanner 410 generates a scan volume from scanning sweeps projected along three generally orthogonal
10 directions, one scanning sweep emanating downwardly and sidewardly from the upper inclined window 425, one scanning sweep emanating sidewardly and upwardly from the vertical window 420, and one scanning sweep emanating generally upwardly through horizontal window 427 off of
15 mirror array 460. The scanning beams emanating from horizontal window 427 may have a sideways component in a direction toward the vertical housing portions 414, 416.

Alternately, the scanning system of Fig. 20 may also be combined with a scale unit or a combined scale-scanner
20 unit. In one alternate embodiment, element 427 may be a weigh scale unit providing weight data and as set forth in the flow chart of Fig. 18 for example, the input from the scale electronics 147 may be sent directly into the micro-processor 140. In yet another alternate embodiment,
25 element 427 may be a combined weigh scale and scanner unit providing both a third scanning sweep and weighing capability. One such combined scale and scanner is disclosed in United States Patent No. 4,971,176 which is hereby incorporated by reference.

30 Although the description and the claims herein use terms such as "up", "down", "vertical", "horizontal", "above", "below", "upper", "higher", "lower", "to the side", "top", "bottom" etc., it should be understood that the terms are used only for convenience in referring to
35 preferred orientation as per the drawings and/or in describing relative directions, and the illustrated and described scanner may be configured or positioned in any

desired orientation. These terms are considered relative and are not intended as limiting the scope of the invention or the claims.

Thus, a scanning system and method for reading data
5 have been shown and described. It is intended that any one of the disclosed outgoing light configurations may be combined with any one of the collecting configurations. Though certain examples and advantages have been disclosed, further advantages and modifications may become
10 obvious to one skilled in the art from the disclosures herein. The invention therefore is not to be limited except in the spirit of the claims that follow.

Claims

1. A scanning system for reading symbols on an object being passed through a scan volume, comprising:
 - a vertically extended housing positioned generally to
 - 5 one side of the scan volume;
 - means for producing at least a first scanning beam and a second scanning beam;
 - an optical scanning element within the housing;
 - a first mirror array positioned in a lower portion of
 - 10 the housing;
 - a second mirror array positioned in an upper portion of the housing;
 - first means for directing the first scanning beam along a first optical path toward a first side of the
 - 15 optical scanning element, the optical scanning element scanning the first scanning beam across the first mirror array; and
 - second means for directing the second scanning beam along a second optical path toward a second side of the
 - 20 optical scanning element, the optical scanning element scanning the second scanning beam across the second mirror array,
 - wherein the first mirror array is constructed and arranged to generate a pattern of scan lines some of which
 - 25 having an upward vertical component and the second mirror array is constructed and arranged to generate a pattern of scan lines some of which having a downward vertical component.
2. A scanning system according to Claim 1 wherein
- 30 the means for producing the first and second scanning beams comprises a first light source generating the first scanning beam and a second light source generating the second scanning beam.
3. A scanning system according to Claim 1 further
- 35 comprising a combination mirror having (a) an outgoing

beam focusing mirror portion and (b) an incoming signal collection mirror portion.

4. A scanning system according to Claim 3 wherein the incoming signal collection mirror portion incoming
5 signal collection mirror portion comprises a concave ellipsoidal mirror and the beam focusing mirror portion comprises a smaller concave parabolic mirror located in the concavity of the concave ellipsoidal mirror.

5. A scanning system according to Claim 1 wherein
10 the optical scanning element is selected from the group consisting of: a rotating optical polygon mirror or a rotating holographic disk, a first and second rotating single facet mirrors, and a first and second pivoting single facet mirrors.

15 6. A scanning system according to Claim 1 wherein the optical scanning element comprises first and second rotating optical polygon mirrors, the first side of the optical scanning element comprising the first rotating optical polygon mirror and the second side of the optical
20 scanning element comprising the second optical polygon mirror.

7. A scanning system according to Claim 1 wherein the first mirror array comprises a plurality of pattern mirrors arranged in a generally semicircular
25 configuration.

8. A scanning system according to Claim 1 wherein the second mirror array comprises a plurality of pattern mirrors arranged in a generally semicircular configuration.

30 9. A scanning system according to Claim 1 wherein the first mirror array directs a majority of the scan

lines in a generally sideways and vertically upward direction.

10. A scanning system according to Claim 1 wherein the first mirror array directs all the scan lines in a
5 generally sideways and vertically upward direction.

11. A scanning system according to Claim 1 wherein the second mirror array directs all the scan lines in a generally sideways and vertically downward direction.

12. A scanning system according to Claim 1 further
10 comprising a first detection system which detects a return carrier signal from the first scanning beam, a second detection system which detects a return carrier signal from the second scanning beam, a processor which processes return carrier signal data from both the first and second
15 detection systems.

13. A scanning system according to Claim 1 further comprising:

a horizontally oriented housing portion positioned generally below the scan volume;

20 means for producing a third scanning beam;

a third mirror array positioned in a horizontally oriented housing position; and

a third means for directing the third scanning beam along a third optical path toward a third side of the
25 optical scanning element, the optical scanning element scanning the third scanning beam across the third mirror array thereby producing a pattern of scan lines having an upward component.

14. A scanning system according to Claim 1 further
30 comprising a w igh scale positioned generally along a horizontal plane adjacent the vertically extended housing.

15. A scanner for reading symbols such as bar codes on an object being passed through a scan volume, comprising:

- 5 a vertically oriented housing positioned generally to one side of the scan volume;
- means for producing at least a first scanning beam and a second scanning beam;
- an optical scanning element within the housing;
- 10 a first mirror array positioned in a lower portion of the housing;
- a second mirror array positioned in an upper portion of the housing;
- 15 a first means for directing the first scanning beam along a first optical path toward a first side of the optical scanning element, the optical scanning element scanning the first scanning beam across the first mirror array thereby producing a generally upwardly and sideways directed scan pattern; and
- 20 a second means for directing the second scanning beam toward a second side of the optical scanning element, the optical scanning element scanning the second scanning beam across the second mirror array thereby producing a generally downwardly and sideways directed scan pattern.

16. A scanner for reading bar codes according to
25 Claim 15 further comprising a first detector for detecting return signal from the first scanning beam, a second detector for detecting return signal from the second scanning beam, and means for processing both the return signal from the first scanning beam and the return signal
30 from the second scanning beam in a single processor.

17. A scanner for reading bar codes according to Claim 15 wherein the first mirror array is constructed and arranged to generate a pattern of scan lines a majority of which having an upward vertical component and some of
35 which having a downward vertical component and the second

mirror array is constructed and arranged to generate a pattern of scan lines a majority of which having a downward vertical component.

18. A scanner for reading bar codes on an object
5 being passed through a scan volume, comprising:

a vertically oriented housing positioned generally to one side of the scan volume;

a multi-faceted rotating polygon mirror within the housing;

10 means for producing at least a first scanning beam and a second scanning beam;

a first mirror array positioned in a lower portion of the housing;

15 a second mirror array positioned in an upper portion of the housing;

a first means for directing the first scanning beam along a first optical path toward a first side of the rotating polygon mirror and to the first mirror array; and

20 a second means for directing the second scanning beam along a second optical path toward a second side of the polygon mirror and to the second mirror array,

wherein the first mirror array is constructed and arranged to generate a pattern of scan lines generally forming a first scan plane and the second mirror array is
25 constructed and arranged to generate a pattern of scan lines generally forming a second scan plane, the first scan plane and the second scan plane being oriented to intersect at an angle greater than approximately 30° to each other.

30 19. A scanner for reading bar codes according to Claim 18 wherein the first mirror array and the second mirror array are constructed and arranged such that the first scan plane intersects the second scan plane at an angle of approximately 60°.

20. A scanner for reading bar codes according to Claim 18 wherein the first mirror array and the second mirror array are constructed and arranged such that the first scan plane intersects the second scan plane in the scan volume.

21. A scanner for reading bar codes on an object being passed through a scan volume, comprising
a single housing comprised of a first housing section, a second housing section, an optical scanning mechanism, a first aperture, a second aperture, a first pattern mirror array positioned in the first housing section, and a second pattern mirror array positioned in the second housing section;

means for generating a first scan beam and a second scan beam;

a first means for directing the first scan beam along a first optical path toward the optical scanning element, to the first pattern mirror array, and out the first aperture; and

a second means for directing the second scan beam along a second optical path toward the optical scanning element, to the second pattern mirror array, and out the second aperture.

22. A scanning system according to Claim 21 wherein the first aperture is oriented in a plane at an oblique angle to a plane of the second aperture.

23. A scanning system according to Claim 22 wherein the angle between the plane of the first aperture and the plane of the second aperture is between 90° and 180°

24. A scanning system according to Claim 22 wherein the angle between the plane of the first aperture and the plane of the second aperture is about 150° .

25. A scanning system according to Claim 21 wherein the first aperture comprises a first window element arranged in a first aperture plane and wherein the second aperture comprises a second window element arranged in a second aperture plane, the second aperture plane being oriented at an oblique angle to the first aperture plane.

26. A scanning system according to Claim 21 wherein the optical scanning element is selected from the group consisting of: a rotating optical polygon, a rotating holographic disk, a pair of rotating single facet mirrors, and a pair of pivoting single facet mirrors.

27. A method for data reading comprising the steps of:

generating at least a first outgoing light beam and a second outgoing light beam;

directing the first outgoing light beam along a first optical path toward a first side of an optical scanning member, to a first pattern mirror array, and out a first aperture toward the object being read;

directing the second outgoing light beam along a second optical path toward a side of the optical scanning member, to a second pattern mirror array, and out a second aperture toward the object being read;

detecting a first carrier signal reflecting off the object from both the first outgoing light beam and detecting a second carrier signal reflecting off the object from the second outgoing light beam;

preprocessing the detected first carrier signal and the second detected carrier signal; and

processing the preprocessed first carrier signal and the preprocessed second carrier signal together in a processor.

28. A method for data reading according to Claim 27 further comprising the step of:

sending the processed signals to a point of sale system for data manipulation.

29. A method for data reading according to Claim 27 further comprising the steps of:

- 5 generating a third outgoing light beam;
- directing the third outgoing light beam along a third optical path toward a side of the optical scanning member, to a third pattern mirror array, and out a third aperture toward the object being read;
- 10 detecting a third carrier signal returning from the object from the third outgoing light beam;
- preprocessing the detected third carrier signal; and
- processing the preprocessed third carrier signal along with the preprocessed first and second carrier
- 15 signals in a processor.

FIG. 1.

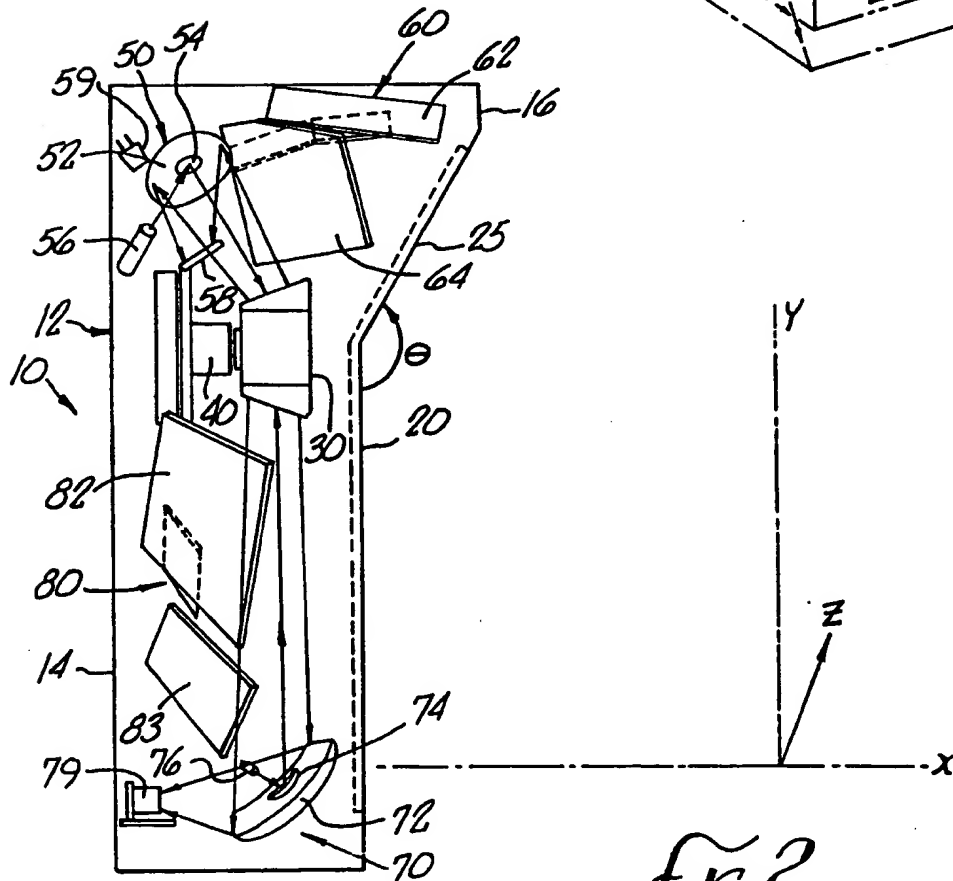
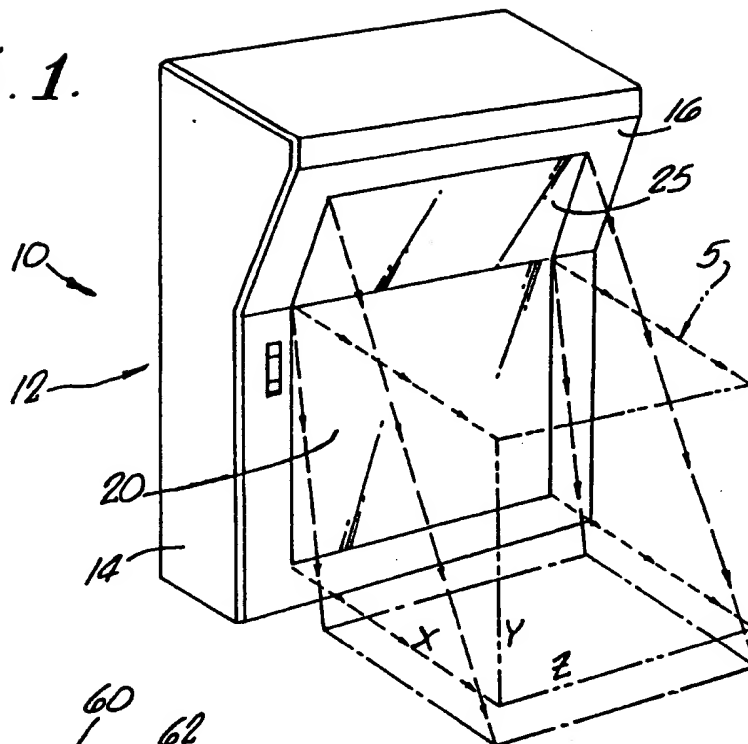


FIG. 2.

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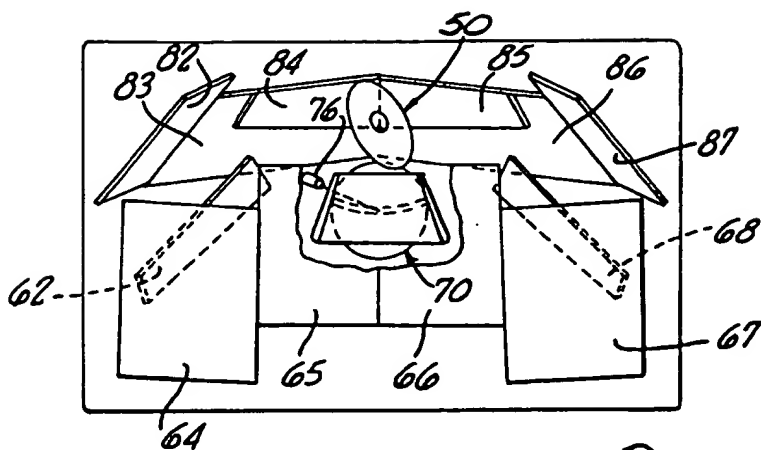


FIG. 3.

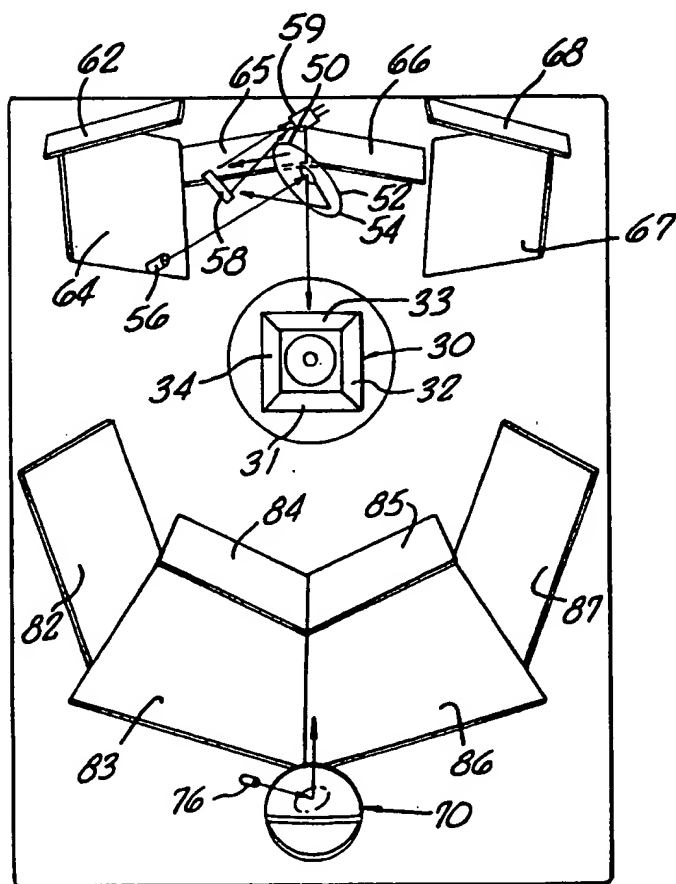


FIG. 4.

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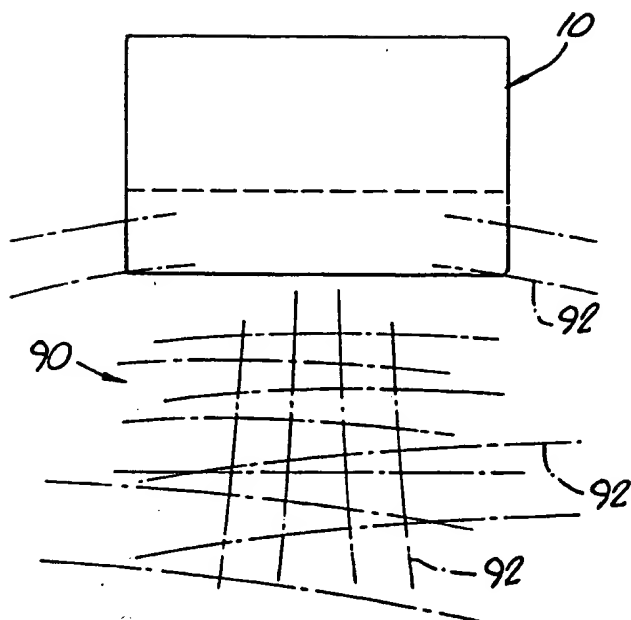


FIG. 5.

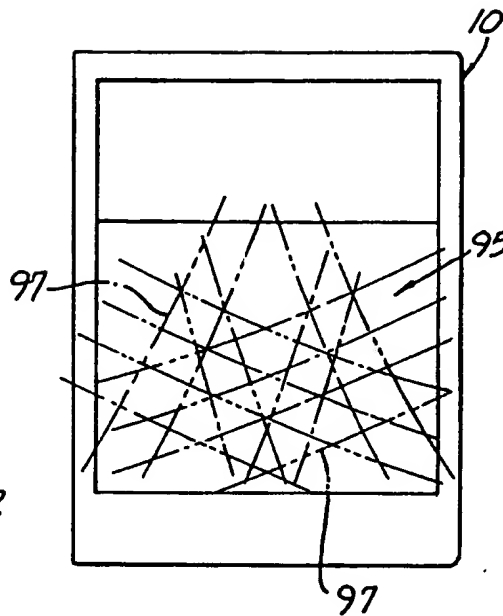


FIG. 6.

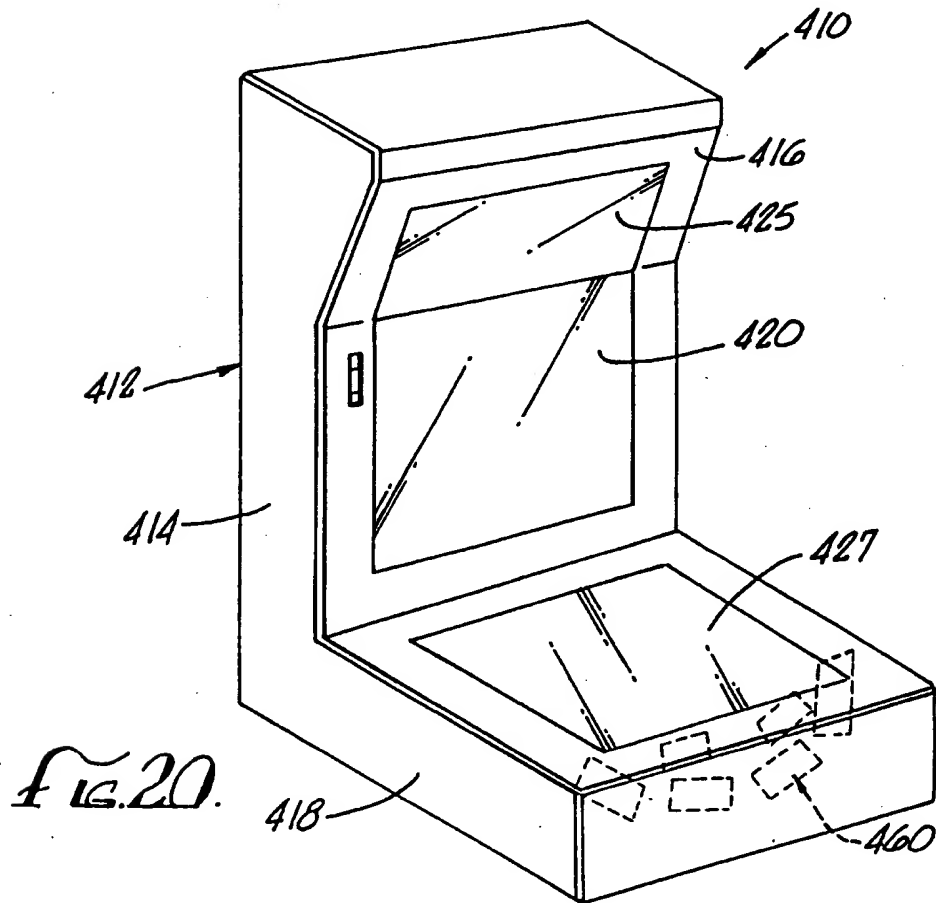
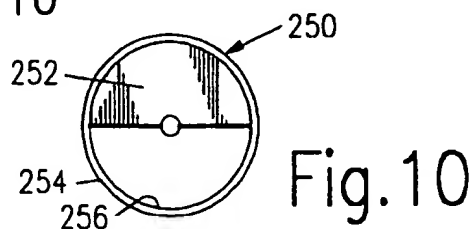
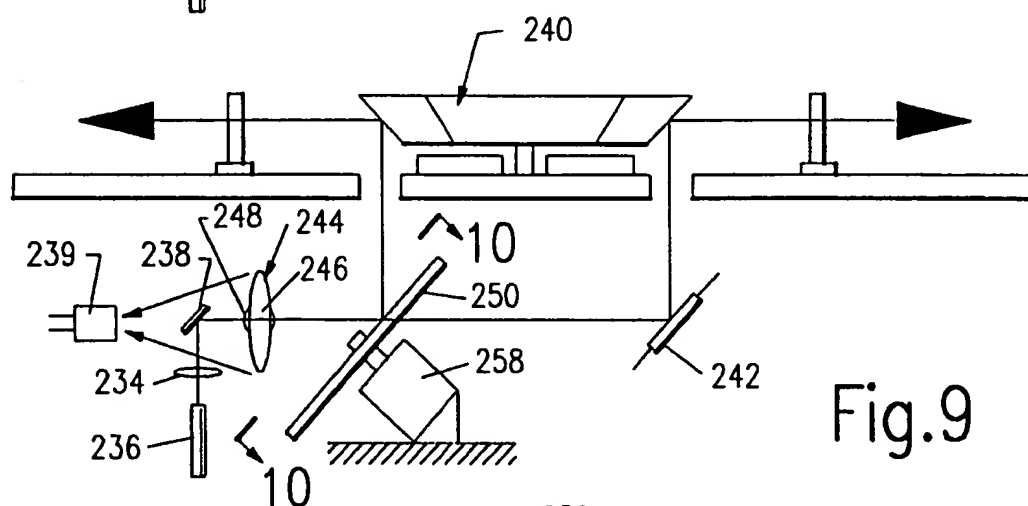
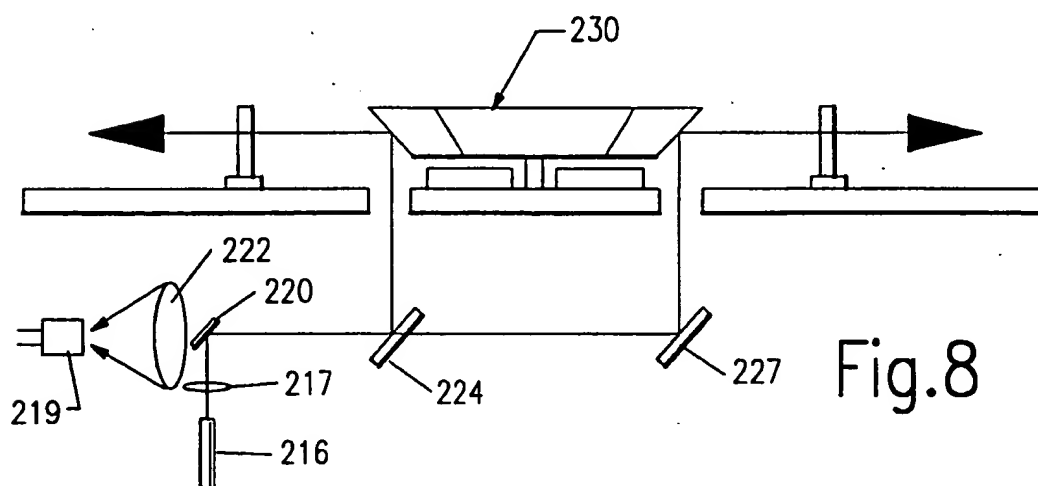
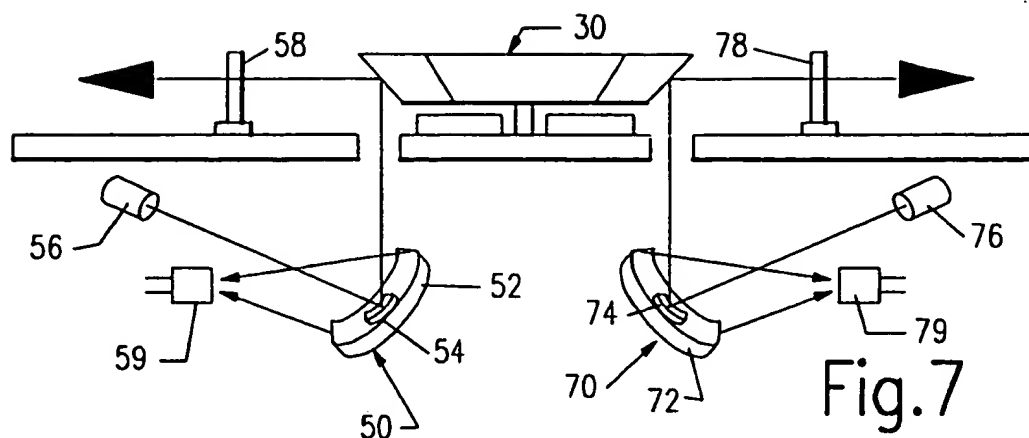


FIG. 20.

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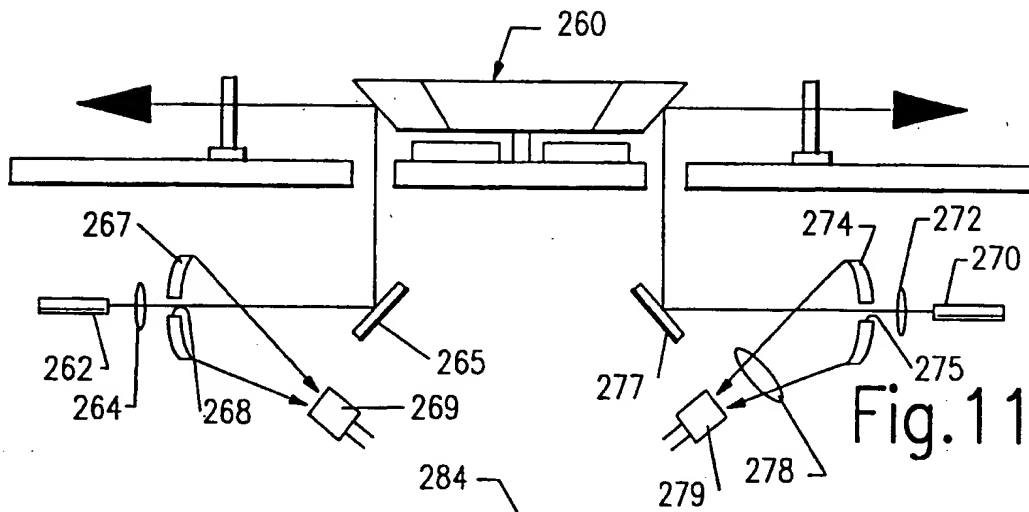


Fig.11

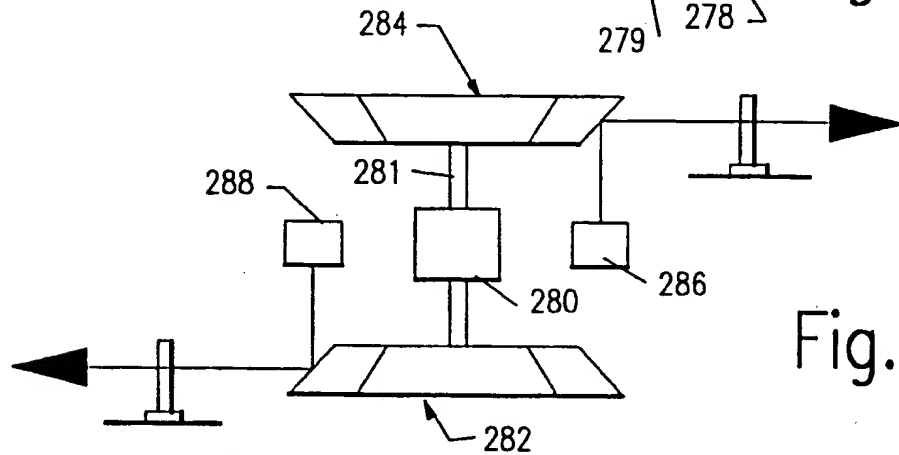


Fig.12

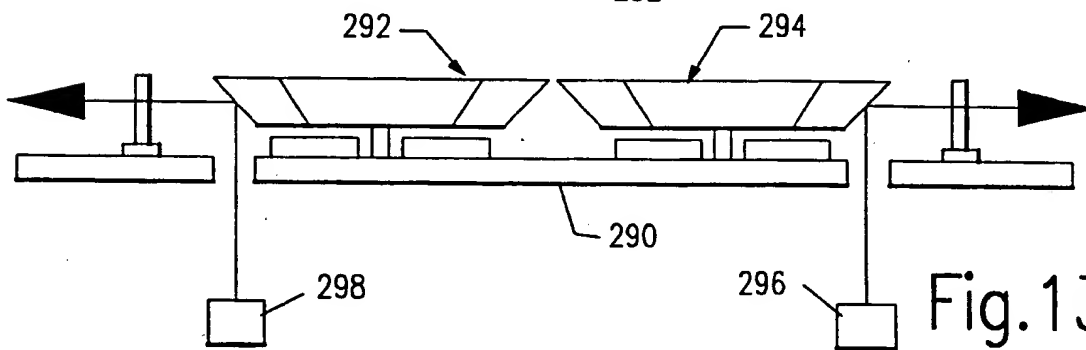


Fig.13

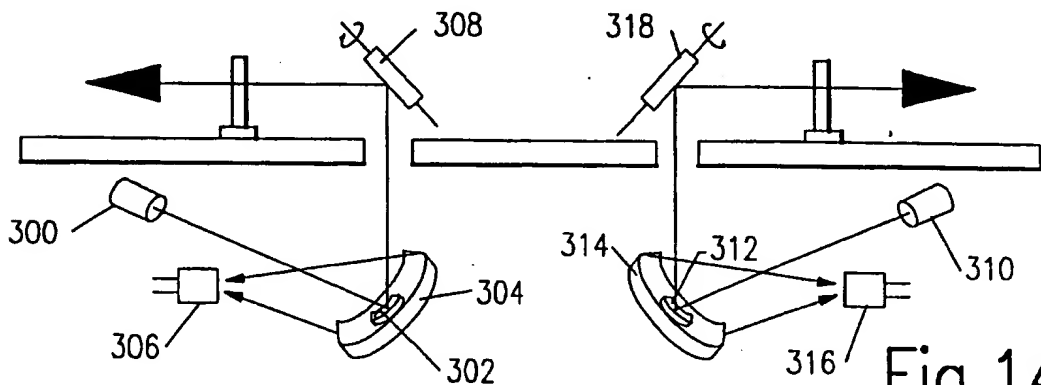


Fig.14

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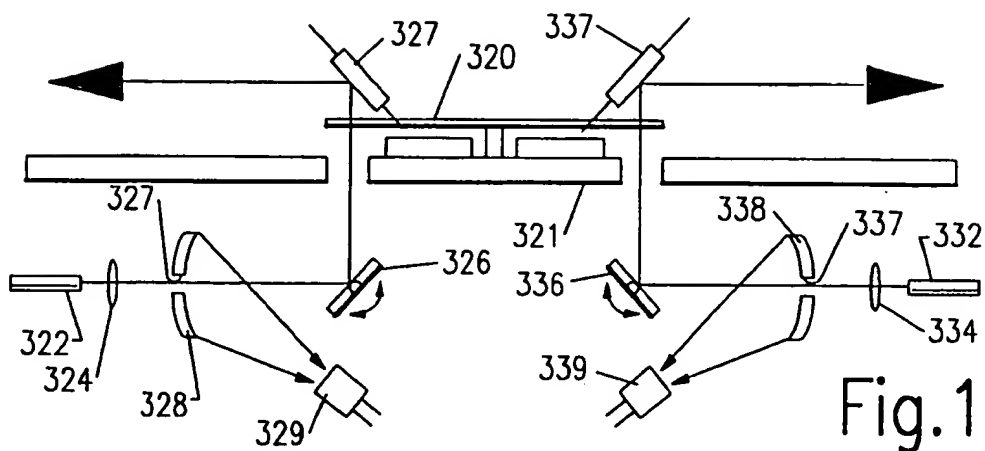


Fig. 15

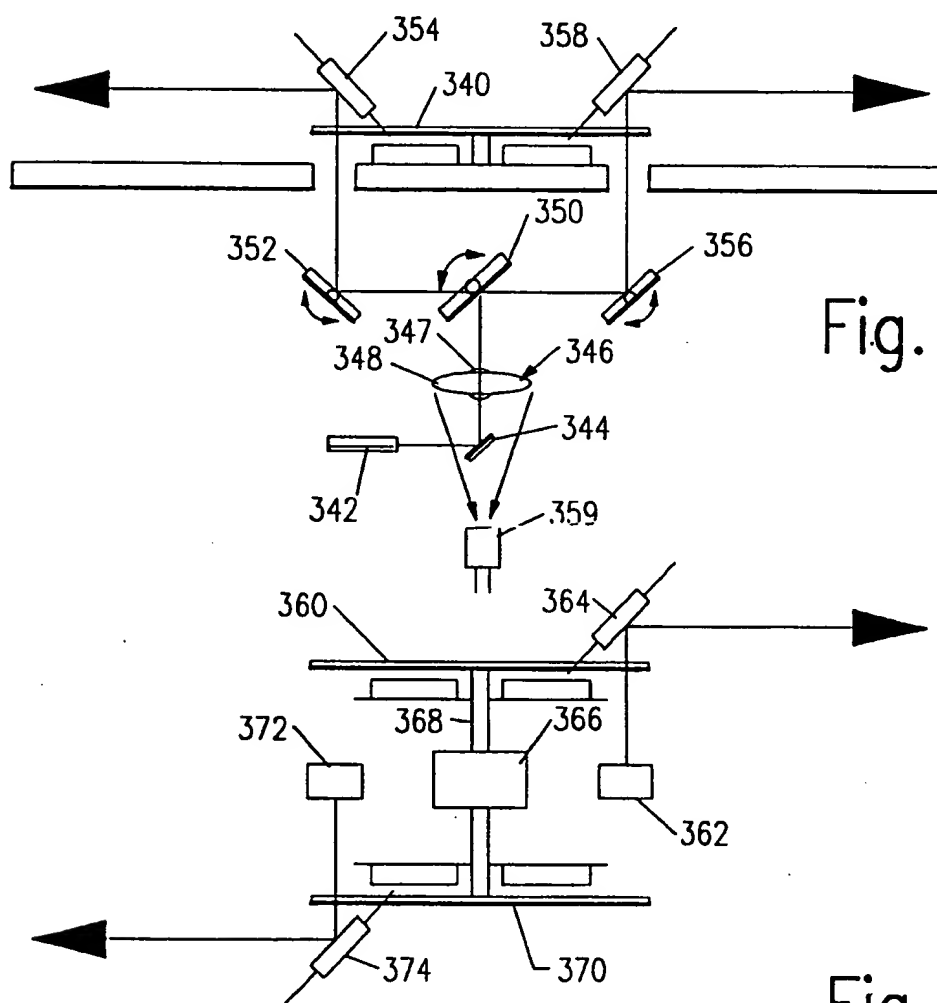


Fig. 16

Fig. 17

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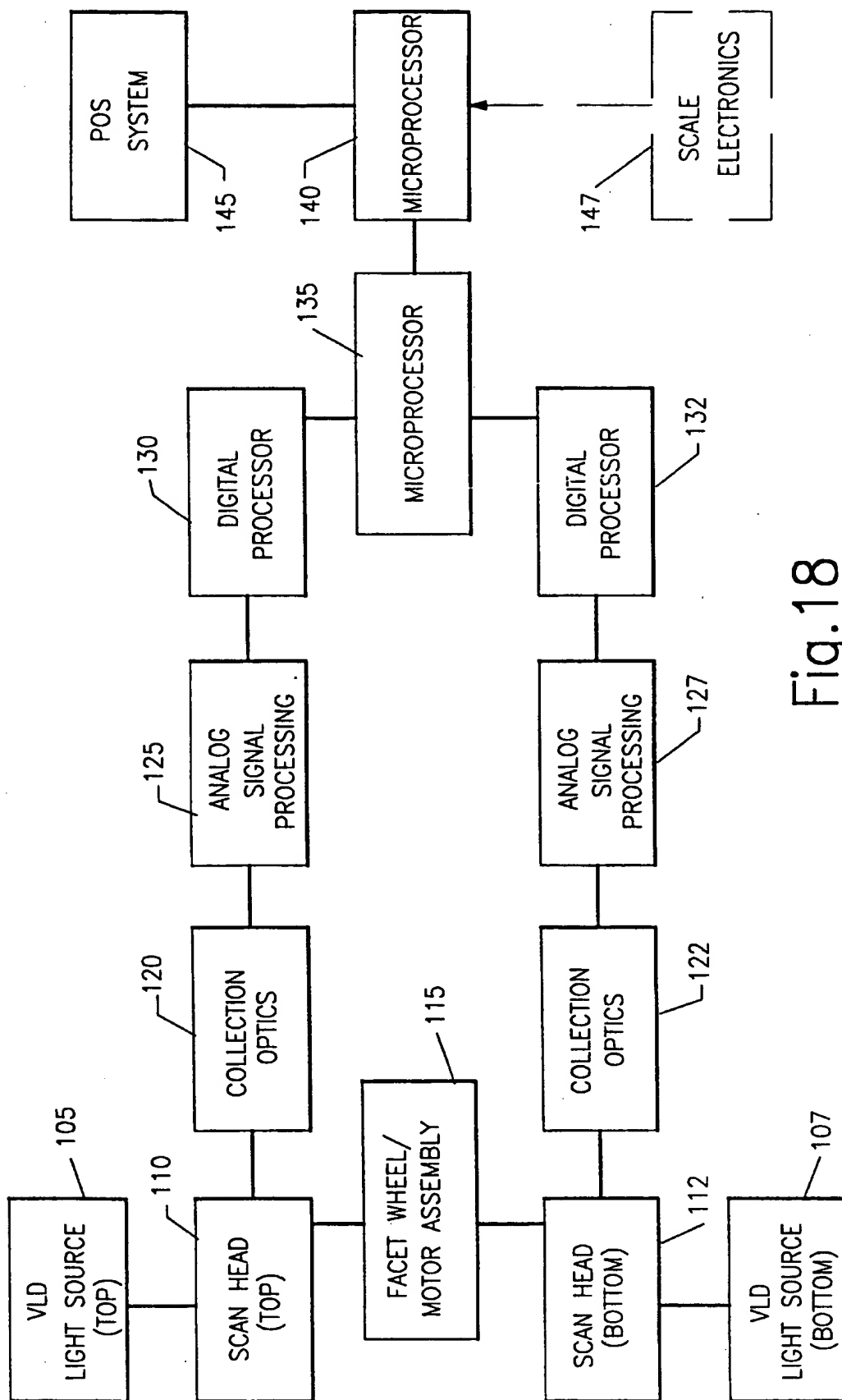


Fig.18

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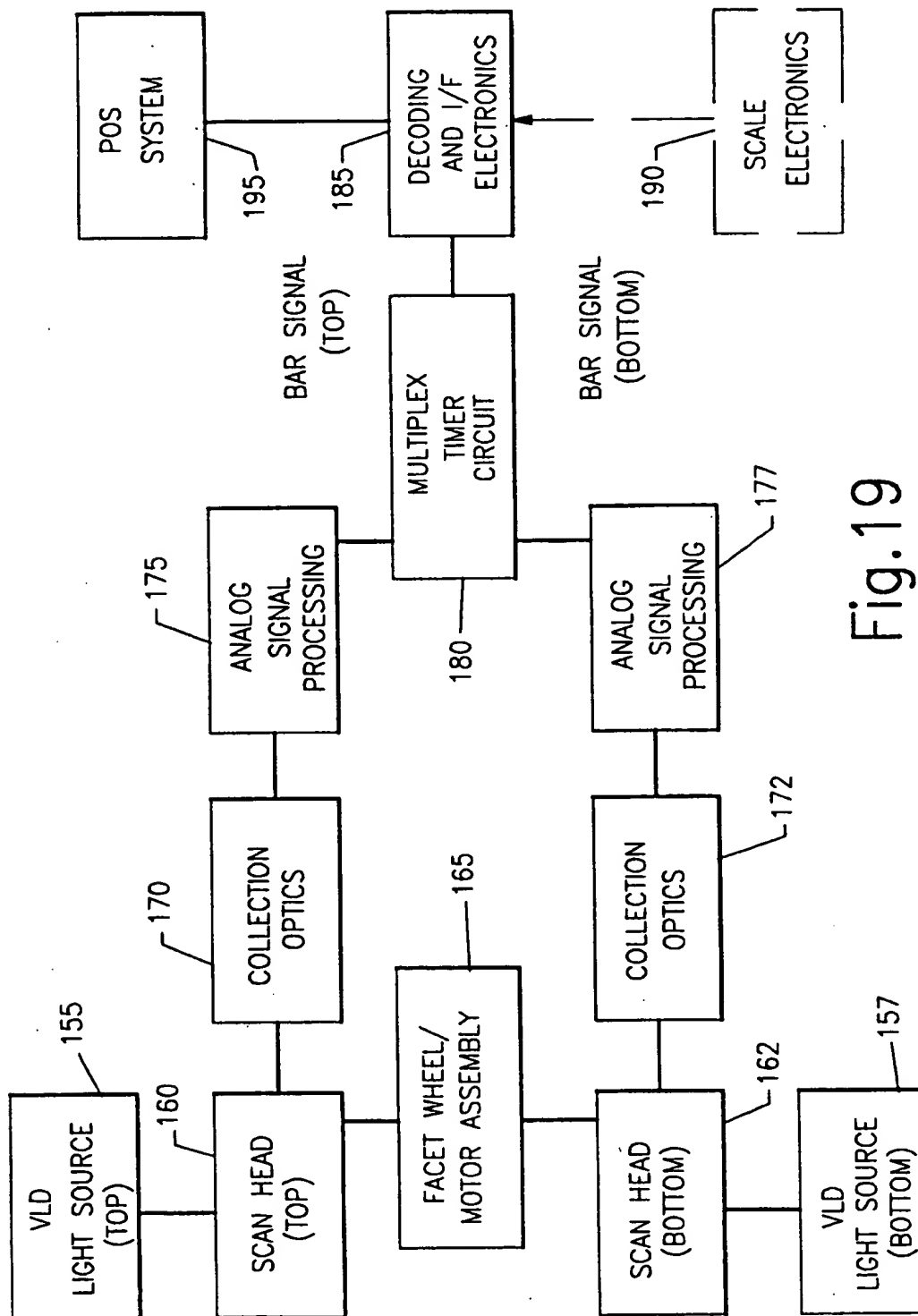


Fig.19

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/06642

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) : G06K 15/00

US CL : 235/375

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 235/375

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	U.S., A, 4,652,732 (NICKL) 24 MARCH 1989, see entire document.	1-29
X	U.S., A, 4,867,257 (KUCHLER) 19 SEPTEMBER 1989, see entire document.	1-29
X	U.S., A, 5,128,520 (RANDO ET AL.) 07 JULY 1992, see entire document.	1-29

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be part of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Z" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 09 SEPTEMBER 1993	Date of mailing of the international search report SEP 1993
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. NOT APPLICABLE	Authorized officer HAROLD PITTS Telephone No. (703) 308-0717